

# APPROVAL SHEET FOR SUSPENDED LOAD OPERATIONS

SLO-KSC-1498-004

TITLE MARS '98 Spacecraft Handling and Mate to  
Delta Third Stage

DOCUMENT NUMBER/TITLE See 'SUPPORTING DOCUMENTS' in  
SLO-KSC-1498-004

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## REQUIRED APPROVAL

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OPERATION: MARS '98 Spacecraft Handling and Mate to Delta Third Stage

SUPPORTING DOCUMENTS: The associated System Assurance Analyses (SAA) and test procedures are as follows:

- SAA 01FS0420-001 - 20-ton Bridge Crane SAEF 2
- Orbiter Lifting - LMA Test Procedure MSP-M-Z-004
- Lander Lifting - LMA Test Procedure MSP-L-Z-006.A
- Orbiter Spin Test - LMA Test Procedure MSP-M-E-011
- Lander Spin Test - LMA Test Procedure MSP-L-E-023
- Launch Preparation Document - LPD G208, Spacecraft Processing

GENERAL DESCRIPTION: The following operations require personnel to work under a suspended load:

Cleaning of the Astroring mating surfaces, removal and reinstallation of Lander spacecraft heat shields and backshells (structural components) and spacecraft mate to the Delta third stage.

These operations require a minimum of two (2) and a maximum of six (6) personnel to work under a suspended load for short periods of time.

The removal and reinstallation of the Lander spacecraft heat shield and backshell are unplanned events caused by the removal of electronic components. This work is accomplished on extremely fragile composite structures which requires custom handling equipment be installed under the heat shield/backshell of the Lander spacecraft. The installation of the handling equipment for the back shell must be accomplished using dedicated lift points under the outer surface of the composite structure. Personnel accomplishing this task are exposed to a maximum weight of 160 pounds.

The mating operation with the Delta third stage requires four (4) personnel to work below the spacecraft when suspended from the overhead bridge crane in SAEF-2 to guide the spacecraft on to the Delta third stage.

The test procedures include requirements for briefings to the participants that include personnel assignments, lifting directions and the requirements to stay out from under suspended loads unless specifically directed by the test conductor / Vehicle Operations Lead.

RATIONALE/ANALYSIS: This Suspended Load Operation Analysis/Approval is required because of unplanned work on the MARS'98 Lander Spacecraft. Electronic

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components within the Lander spacecraft failed. This requires the unplanned removal of the Lander heat shield, backshell and other components to remove the suspect electronic components. Due to the exceptionally fragile nature of the heat shield and backshell only special lift points may be used for the removal and installation activity. This presents the potential hazard associated with suspended loads.

Additionally, personnel are required to inspect and clean the Astrorings of the Orbiter and Lander spacecraft prior to mating this critical surface with handling equipment and the Delta third stage. The inspection and cleaning process requires a hand surface inspection followed by an alcohol wipe of the surface which is under the envelop of the spacecraft structure.

These suspended load operation comply with the NASA Alternate Safety Standard for Suspended Load Operations as follows:

Alternate Standard Requirement 1a: The spacecraft mating/separation ring is smaller in diameter than the outer diameter of the spacecraft. It is necessary to position personnel beneath the spacecraft to clean and inspect the mating surfaces and to ensure proper mating and prevent damage to the flight separation interface.

Alternate Standard Requirement 1b: The possible use of a secondary support system was analyzed and determined not feasible because the separation interface represents the only primary structure support for the spacecraft.

Alternate Standard Requirement 1c: Test procedures will limit the number of personnel beneath the suspended load to no more than six (6) for heat shield and back shell removal / reinstallation. The test procedure will limit the number of personnel beneath the suspended load to no more than two (2) for Astroring inspection and cleaning. The test procedures will limit the number of personnel beneath the suspended load to no more than four (4) for mating the spacecraft to the Delta third stage.

Alternate Standard Requirement 1d: Personnel that perform the installation of handling equipment on the heat shield and backshell of the Lander spacecraft will be exposed for no more than ten (10) minutes. Personnel that accomplish the cleaning and inspection of the Astrorings will be exposed for no more than five (5) minutes. Personnel will perform the spacecraft mate to the Delta third stage as quickly and safely as possible to minimize exposure. The suspended load operation is estimated to take approximately 30 minutes.



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Alternate Standard Requirement 4: Operational requirements will be included in test procedures which will be on-site for inspection.

Alternate Standard Requirement 5: If during the operations listed above it is necessary to develop a new operations procedure, the NASA Center Safety Office will be consulted and must approve and document the procedure before operations continue. Safety will accomplish the required coordination with Operations, Engineering and other organizations as appropriate. If the new procedure is to be used on a regular basis, a hazard analysis will be accomplished and necessary NASA approval will be required.

Alternate Standard Requirement 6: The suspended load operations covered by this report are performed at SAEF 2 using the 20-ton bridge crane. The crane was designed, tested, inspected, maintained and operated in accordance with the NASA Safety Standard for Lifting Devices and Equipment, NSS/GO-1740.9.

The crane is load tested annually at 100% of rated capacity and there is a preventive maintenance program to ensure proper operation. All aspects of the crane controls are verified before each use and load holding/brake capability is tested annually.

The spacecraft lift fixtures meet a design safety factor of five times ultimate strength. The approximate weight of the Lander spacecraft, without propellant is approximately 1000 pounds and 1150 pounds with fuel. The approximate weight of the fueled Orbiter spacecraft is 2600 pounds. The weight of the heat shield or backshell is approximately 160 pounds.

Operation of the crane will be by trained and certified operators per KMI 6340.4, Examination and Licensing of KSC Facility Crane Operators.

An individual will be stationed at the crane main circuit breaker during hoisting to immediately remove power, thus setting the brakes, should a failure occur with the crane controls.

Alternate Standard Requirement 7: SAAs have been completed on the SAEF-2 20-ton bridge crane. The SAA includes a Failure Modes and Effects Analysis/Critical Item List (FMEA/CIL) and a Hazard Analysis.

The SAA (SAA 01FS0420-01) for the SAEF 2 20-ton bridge crane identify no Category 1 Mechanical or Electrical Critical Items.

Alternate Standard Requirement 8: Visual inspections of the lifting equipment as well as crane functional checks will be performed prior to each use.

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Alternate Standard Requirement 9: Trained and certified operators shall man the crane controls at all times when personnel are beneath the suspended load.

Alternate Standard Requirement 10: Appropriate safety control areas are established before initiating operations. Only the minimum number of personnel will be permitted in this area.

Alternate Standard Requirement 11: A pretask briefing and a safety walkdown of the area are conducted prior to the lift to ensure all systems and personnel are ready to support.

Alternate Standard Requirement 12: Personnel beneath the suspended load will be in voice contact with the crane operator and task leader throughout the operation. At any time during the operation anyone can call a safety hold if they see a discrepancy. The crane operator will have full visual contact with the load throughout the operation.

Alternate Standard Requirement 13: The task leader and crane operator will be in visual contact with personnel beneath the suspended load throughout the operation.

Approval:

Date: 10/7/98

*Malcolm Kern for per telecon with Bruce Hansen (EI) 10/7/98*  
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